HEATING, VENTILATION, AIR CONDITIONING, AND REFRIGERATION
HVAC/R II

COURSE DESCRIPTION

HVAC/R II is a course in which students will extend their skills and knowledge related to residential and commercial heating, ventilation, air conditioning, and refrigeration (HVAC/R). Topics covered include electricity, thermodynamics, psychometrics, diagnostic, forced air furnaces, air distribution systems, and heating/cooling load analysis. This course gives students a substantial skill and knowledge foundation typically required for apprentice HVAC/R technicians. Course content provides school based and work based learning opportunities for students. Course content prepares students for entry level employment, advanced training in HVAC/R, and entry into post secondary education.

Prerequisite(s):	HVAC/R I, Algebra I or Math for Technology II Geometry, Principles of Technology I or Physical Science (may be concurrent)
Recommended Credits:	2
Recommended Grade Level(s):	11^{th} or 12^{th}

HEATING, VENTILATION, AIR CONDITIONING AND REFRIGERATION HVAC/R II) STANDARDS

1.0 Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.

2.0 Students will demonstrate safety practices, including Occupational Safety and Health Administration (OSHA) and Environmental Protection Agency (EPA) requirements.

3.0 Students will relate knowledge and skill pertaining to electricity to heating, ventilation, air conditioning and refrigeration systems.

4.0 Students will interpret, lay out, and fabricate in conformance to construction drawings and written specifications.

5.0 Students will examine the processes used to transfer heat and humidity.

6.0 Students will diagnose and service heating, ventilation, air conditioning, and refrigeration systems.

7.0 Students will make psychometric measurements and calculations.

8.0 Students will design, troubleshoot, and install air distribution systems and components.

9,0 Students will demonstrate interpersonal and employability skills required in the heating, ventilation, air conditioning, and refrigeration industry.

10.0 Students will communicate skills required in the heating, ventilation, air conditioning, and refrigeration industry.

11.0 Students will analyze heating, ventilation, air conditioning, and refrigeration knowledge and skills and apply in a work-based or school project-based learning experience.

HEATING, VENTILATION, AIR CONDITIONING, AND REFRIGERATION (HVAC/R II)

STANDARD 1.0

Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.

LEARNING EXPECTATIONS

The student will:
1.1 Demonstrate leadership skills.
1.2 Use problem-solving techniques to address and propose solutions to school, community, and workplace problems.
1.3 Demonstrate the ability to work professionally with others.
1.4 Participate in SkillsUSA-VICA as an integral part of instruction.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:
1.1.A Exhibits integrity and pride in workmanship.
1.1.B Keeps group work focused on task.
1.2.A Determines the root causes of observed conflicts or problems.
1.2.B Mediates disputes between parties.
1.3.A Participates in a job shadowing experience.
1.3.B Assembles a student team to solve an assigned problem.
1.4.A Attends and participates in periodic meetings of SkillsUSA-VICA or similar organization.

SAMPLE PERFORMANCE TASKS

- Prepare a resume.
- Participate in various SkillsUSA-VICA or similar programs and/or competitive events.
- Attend a professional organization meeting such as, local Chamber of Commerce meeting.
- Participate in the American Spirit Award competition with SkillsUSA-VICA.
- Participate in job shadowing or internship program with local business or industry.
- Take an active role in a group project assigned by the instructor.
- Identify and detail a problem area in the school, community, or workplace, and propose solutions. If possible, and with appropriate approvals, implement or facilitate the solution.

INTEGRATION LINKAGES

SkillsUSA-VICA, *Professional Development Program,* SkillsUSA-VICA, Communications and Writing Skills, Teambuilding Skills, Research, Language Arts, Sociology, Psychology, Algebra, Geometry, Applied Communications, Social Studies, Problem Solving, Interpersonal Skills, Employability Skills, Critical-Thinking Skills, SCANS (Secretary's Commission on Achieving Necessary Skills), Chamber of Commerce, Colleges, Universities, Technology Centers, and Employment Agencies

HEATING, VENTILATION, AIR CONDITIONING, AND REFRIGERATION (HVAC/R II)

STANDARD 2.0

Students will demonstrate safety practices, including Occupational Safety and Health Administration (OSHA) and Environmental Protection Agency (EPA) requirements.

LEARNING EXPECTATIONS

The student will:

2.1 Determine safe and correct procedures for working with electricity in heating, ventilation, air conditioning, and refrigeration.
2.2 Use protective clothing, eye protection, and safety equipment.
2.3 Use fire protection equipment.
2.4 Follow OSHA and EPA regulations and manufacturers specifications according to the heating, ventilation, air conditioning, and refrigeration.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

2.1.A Conforms to federal, state, local regulations, and manufacturer's specifications when working with electricity.
2.1.C Inspects first aid supplies and determines supplies and procedures for electrical injuries.
2.2.A Demonstrates proper usage of special safety equipment used while working on heating, ventilation, air conditioning, and refrigeration systems.
2.2.B Selects and uses the appropriate protective clothing and eye protection.
2.3.A Selects the proper fire extinguisher for an electrical or chemical fire.
2.3.B Demonstrates the proper use of a fire extinguisher and determines effectiveness.
2.4.A Locates regulatory information and manufacturer recall information pertaining to heating, ventilation, air conditioning, and refrigeration systems.
2.4.B Extracts information from Material Safety Data Sheets.
2.4.C Complies with relevant regulations and standards pertaining to heating, ventilation, air conditioning, and refrigeration
2.4.D Passes with 100% accuracy a written examination relating specifically to heating, ventilation, air conditioning, and refrigeration safety issues.
2.4.E Passes with 100% accuracy a performance examination relating specifically to heating, ventilation, air conditioning, and refrigeration tools and equipment.
2.4.F Maintains a portfolio record of written safety examinations and equipment examinations for which the student has passed an operational checkout by the instructor.
2.5.A Interprets manufacturer correspondence for safety regulations.
2.5.B Complies with safety procedures.

SAMPLE PERFORMANCE TASKS

- Assess the work area for safety hazards.
- Design a corrections program for identified hazards.
- Model the appropriate protective equipment for an assigned task.
- Read manufacturer specifications to determine safe practices while working on various electrical and electronic systems.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Applied Communications, Algebra, Geometry, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Environmental Protection Agency (EPA), United States Department of Labor, Tennessee Department of Labor and Workforce Development, Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers, ASHRAE), Air Conditioning Contractors of America (ACCA), Occupational Safety and Health Administration (OSHA), Refrigeration Service Engineers Society (RSES)

HEATING, VENTILATION, AIR CONDITIONING, AND REFRIGERATION (HVAC/R II)

STANDARD 3.0

Students will relate knowledge and skill pertaining to electricity to heating, ventilation, air conditioning and refrigeration systems.

LEARNING EXPECTATIONS

The student will:

3.1 Analyze the basic characteristics of electricity.
3.2 Apply Ohm's law to heating, ventilation, air conditioning and refrigerationsystems.
3.3 Examine electrical circuits and components of heating, ventilation, air conditioning, and refrigeration systems.
3.4 Determine the role of electromagnetism as related to motors.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

3.1.A Correlates basic electrical concepts with heating, ventilation, air conditioning, and refrigeration.
3.1.B Illustrates the concepts of valence, voltage, current, resistance, and voltage drop.
3.1.C Compares the two theories of current flow and indicates which theory(s) are used in heating, ventilation, air conditioning, and refrigeration systems.
3.1.D Distinguishes between conductor, insulator, and semi-conductor
3.1.E Distinguishes between DC (direct current) and AC (alternating current).
3.2.A Deduces the cause and effect relationship in Ohm's law between voltage, current, resistance, and voltage drop.
3.2.B Uses Ohm's law to determine values mathematically.
3.3.A Analyzes series circuit structure both in application and mathematically.
3.3.B Analyzes parallel circuit structure both in application and mathematically.
3.3.C Analyzes series-parallel circuit structure both in application and mathematically.
3.3.D Differentiates between a short and a ground.
3.3.E Compares magnetism and electromagnetism.
3.4.B Illustrates electromagnetic induction.
3.4.C Compares concepts of magnetism to their electrical counterparts: reluctance to resistance, field distance to voltage, and magnetic force to current.
3.4.D Analyzes the role of magnetism and electromagnetic induction in heating, ventilation, air conditioning, and refrigeration systems and motor components.

SAMPLE PERFORMANCE TASKS

- Use appropriate instruments and meters to measure watts, volts, Ohms, and amps.
- Demonstrate the proper use of an ammeter, ohmmeter, voltmeter, and wattmeter.
- Select appropriate meter to check capacitance.
- Construct series and parallel circuits.

- Select proper fuse or breaker for a given size wire.
- Determine the capacities of a given run capacitor.

INTEGRATION/LINKAGES

Science, Computer Skills, Research and Writing skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Algebra, Geometry, Applied Communications, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, Plumbing, Heating, and Cooling Contractors (PHCC), Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers, ASHRAE), Air Conditioning Contractors of America (ACCA), Occupational Safety and Health Administration (OSHA), Refrigeration Service Engineers Society (RSES)

HEATING, VENTILATION, AIR CONDITIONING, AND REFRIGERATION (HVAC/R II)

STANDARD 4.0

Students will interpret, lay out, and fabricate in conformance to construction drawings and written specifications.

LEARNING EXPECTATIONS

The student will:

4.1 Interpret dimensions and locations of components that are explicitly dimensioned in construction drawings and written specification.
4.2 Scale dimensions that are not explicitly included in construction drawings.
4.3 Interpret plan and elevation views shown in construction drawings.
4.4 Recognize and interpret lines and symbols commonly used in construction drawings.
4.5 Make layouts of locations and elevations of structural elements and heating, ventilation, air conditioning, and refrigeration components.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

4.1.A Makes a material take-off in conformance to construction drawings and specifications.
4.1.B Lays out components and their locations to dimensions and tolerances indicated on construction drawings and written specifications.
4.2.A Uses the scale of a drawing to determine locations not explicitly dimensioned.
4.2.B Uses the scale of a drawing to determine dimensions not explicitly shown on drawing.
4.3 Interprets three-dimensional features found in construction drawings.
4.4.A Readily relates electrical components and nodes with symbolic components and nodes in electrical schematics and ladder diagrams.
4.4.B Readily relates physical HVAC/R components and piping connections with symbolic components and piping symbols in HVAC/R drawings.
4.5.A Lays out locations and elevations of HVAC/R piping rough -in based on construction drawings.
4.5.B Lays out locations and elevations of HVAC/R ductwork based on construction drawings.
4.5.c Adheres to compliance with state and local electrical codes as applicable to a given installation process relating to HVAC/R.

SAMPLE PERFORMANCE TASKS

- Given a set of plans and specifications for a residential or commercial structure, make a complete material take-off for the HVAC/R components.
- Given a set of plans and specifications for a residential or commercial structure, determine the location of HVAC/R elements not explicitly dimensioned.
- Determine the detail of specified routing and structural supports for ductwork shown in construction drawings.

- Given electrical schematics or ladder diagrams for an existing HVAC/R control system, perform a series of voltage measurements at teacher-designated locations on the schematic or diagram.
- Select sites that ensure proper clearance for serviceability and accessibility of the evaporator, condensing unit, access to electrical controls, and complies with local codes.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Algebra, Geometry, Applied Communications, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, Plumbing, Heating, and Cooling Contractors (PHCC), Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers, ASHRAE), Air Conditioning Contractors of America (ACCA), Occupational Safety and Health Administration (OSHA), Refrigeration Service Engineers Society (RSES)

HEATING, VENTILATION, AIR CONDITIONING, AND REFRIGERATION (HVAC/R II)

STANDARD 5.0

Students will examine the processes used to transfer heat and humidity.

LEARNING EXPECTATIONS

The student will:
5.1 Analyze and quantify heat transfer by thermal conductivity.
5.2 Analyze and quantify heat transfer by convection.
5.3 Analyze and quantify heat transfer by radiation.
5.4 Service, and troubleshoot humidifiers in HVAC/R systems.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:
5.1.A Compares and contrasts thermal and electrical conductivity of given materials.
5.1.B Examines the decrease in efficiency of heat exchangers due to the build-up of scale or corrosion products.
5.1.C Determines the total R-value of a specified wall, roof, or duct, given drawings and specifications.
5.2.A Compares and contrasts heat transfer by natural and forced convection.
5.2.B Calculates the rate of heat transfer, based on measurements of temperature and airflow rates in heating ducts.
5.3.A Calculates heat emission of a radiator, given the emissivity, area, and temperature of the radiator, such as heat lamps or electric heating elements.
5.3.B Calculates the change in heat emission of the above radiator due to an increase in temperature, such as a 20% increase.
5.4.A Makes psychometric measurements and determine relative humidity and water content of the air.
5.4.B Identifies types of humidifiers in residential and commercial HVAC/R systems.
5.4.C Services and troubleshoots humidifiers and their controls.

SAMPLE PERFORMANCE TASKS

- Use approved techniques to measure temperature and velocity in an air duct. Calculate the rate of heat transfer through the duct.
- Given construction drawings and specifications, determine R-values for various wall and roof sections.
- Measure the temperature rise in a wooden block a specified distance from a heat lamp.
- Make wet- and dry-bulb measurements of a room, with and without an operating humidifier. Calculate relative humidity and water content of the air and gage the performance of the humidifying equipment.

INTEGRATION LINKAGES

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HEATING, VENTILATION, AIR CONDITIONING, AND REFRIGERATION (HVAC/R II)

STANDARD 6.0

Students will diagnose and service heating, ventilation, air conditioning, and refrigeration systems.

LEARNING EXPECTATIONS

The student will:

6.1 Differentiate functions of major components of electric and gas-fired forced-air furnaces.
6.2 Examine the principles of combustion and control of gas-fired furnaces.
6.3 Examine the operation and control of electric furnaces.
6.4 Service and troubleshoot forced-air furnaces.
6.5 Implement a systematic diagnostic procedure to diagnose and service problems.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

6.1.A Describes the purpose of the heat exchanger.
6.1.B Describes the purpose and operation of the burner and combustion chamber in gas-fired furnaces.
6.1.C Describes the purpose and operation of the electric heating systems in forced air furnaces.
6.1.D Analyzes the electrical schematics of gas-fired and electric furnaces and create flow-charts of start-up and shutdown of the heating process.
6.2.A Compares and contrasts natural and forced draft gas-fired furnaces.
6.2.B Troubleshoots control systems for gas-fired furnaces.
6.2.C Verifies operation of all safety interlocks and sensors on a gas-fired furnace.
6.2.D Verifies correct operation of vents and flues of a gas-fired furnace.
6.3.A Calculates the expected BTU output of electric heating elements from resistance measurements of cold elements.
6.3.B Calculates the actual BTU output of electric heating elements from voltage and current measurements of operating elements.
6.3.C Analyzes the electrical schematics of electric furnaces and create flow-charts of the start-up and shutdown of the heating process.
6.4.A Measures the airflow through a forced-air furnace.
6.4.B Makes wet/dry bulb measurements of the intake of output air of a furnace and calculate the heat load on the furnace.
6.4.C Verifies the correct sequencing of a gas-fired furnace.
6.4.D Verifies the correct sequencing of an electric furnace.
6.5 Follows strategy based diagnostic procedure to verify the complaint, define the problem, isolate the problem, validate the problem, make the repair, and test the repair. Completes a repair order using technical writing skills and calculate salary earnings based on the repair order description and manufacture allowances for each item on the work order. Calculates manufacturer labor operation time used in the diagnostic process.

SAMPLE PERFORMANCE TASKS

- Determine the BTU output of an electric furnace by psychometric measurements and calculations and compare with the electrical input power.
- Determine and demonstrate the changes necessary when a given gas-fired furnace is switched from propane to a local natural gas supply in your location.
- Demonstrate how to verify that a gas-fired furnace is adjusted for proper combustion.
- Using case scenarios the student follows a strategy based diagnostic procedure to verify the complaint, define the problem, isolate the problem, validate the problem, make the repair, and test the repair. Complete a repair order using technical writing skills and calculate salary earnings based on the repair order description and manufacture allowances for each item on the work order. Calculate manufacturer labor operation time used in the diagnostic process.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Algebra, Geometry, Applied Communications, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, Plumbing, Heating, and Cooling Contractors (PHCC), Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers, ASHRAE), Air Conditioning Contractors of America (ACCA), Occupational Safety and Health Administration (OSHA), Refrigeration Service Engineers Society (RSES)

HEATING, VENTILATION, AIR CONDITIONING, AND REFRIGERATION (HVAC/R II)

STANDARD 7.0

Students will make psychometric measurements and calculations.

LEARNING EXPECTATIONS

The student will:

7.1 Relate the composition of the atmosphere to human health and comfort.
7.2 Make psychometric measurements.
7.3 Evaluate air properties and changes in air properties from the psychometric chart.
7.4 Calculate heating or cooling loads on operating HVAC/R systems from psychometric measurements.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

7.1.A Identifies the major components of the atmosphere and approximate concentrations.
7.1.B Explains the concept of partial pressure of gas mixtures.
7.1.C Explains the relationship between atmospheric pressure and oxygen concentration to human needs.
7.1.D Relates relative humidity to human comfort and health.
7.2.A Makes wet/dry bulb temperature measurement.
7.2.B Measures air velocity and pressure in ducts.
7.2.C Measures relative humidity.
7.2.D Makes differential pressure measurements across components in air distribution systems.
7.3.A Determines relative humidity, water content, from sling psychrometer data and the psychrometric chart.
7.3.B Determines change in enthalpy, sensible heat factor, and total cooling load across an evaporator.
7.3.C Calculates fan power from differential air pressure and air volume measurements.
7.4.A Determines the change in enthalpy across a forced-air furnace.
7.4.B Determines the rate of airflow through a forced-air furnace.
7.4.C Calculates the total heating load on a forced-air furnace.

SAMPLE PERFORMANCE TASKS

- Determine the cooling load and power consumption of a cooling system. Calculate the efficiency of the system.
- Apportion the cost of operating a cooling system between sensible heat loads and latent heat loads.

INTEGRATION LINKAGES

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HEATING, VENTILATION, AIR CONDITIONING, AND REFRIGERATION (HVAC/R II)

STANDARD 8.0

Students will design, troubleshoot, and install air distribution systems and components.

LEARNING EXPECTATIONS

The student will:

8.1 Determine the air flow requirements for an air distribution system.
8.2 Compare and contrast types of fans and blowers for air distribution systems.
8.3 Comprehend and apply the fan laws to air distribution systems
8.4 Comprehend and troubleshoot controls and sensors used in air distribution systems.
8.5 Design and evaluate the performance of air distribution systems.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

8.1.A Determines the air exchange, and fresh air requirement for a given space and use based on current ASHRAE Standard 62 and local HVAC/R codes.
8.1.B Determines the airflow requirement to provide heating and cooling for a given space and use based on industry standards and HVAC/R codes.
8.2.A Evaluates possible fans and blowers for an otherwise specified air distribution system.
8.2.B Determines the speed and power requirements for fan and blower motors.
8.2.C Examines the efficiency, cost, and noise performance of different type of fans and blowers.
8.3.A Uses the fan laws to predict changes in fan and motor requirements due to proposed changes in an air distribution system.
8.4.A Verifies proper blower motor sequencing and blower speed changes for both heating and cooling in a forced-air system.
8.4.B Balances air flow to meet design heating and cooling goals.
8.5.A Designs a suitable duct system with appropriate controls for a specified building and use based on industry standards and HVAC/R codes.
8.5.B Estimates pressure loss in each branch of the duct system and determines blower pressure requirement.
8.5.C Measures static air pressures and velocities in all branches of an air distribution system.
8.5.D Compares measured pressure and velocities with design parameters.
8.5.E Identifies the cause of any significant deviations in air distribution performance from design parameters.
8.5.F Proposes corrective action to achieve design goals in air distribution.

SAMPLE PERFORMANCE TASKS

- Determine airflow required to meet air exchange needs and heating/cooling needs for several rooms (classroom, shop, gym, etc) in the school.
- Design a complete air distribution system for a small commercial building.
- Design a complete air distribution system for a large residential structure.
- Measure differential pressure across and flow through a blower, motor current and voltage. Compare the power of the moving air with electrical input power. Find the efficiency of the blower and motor.

INTEGRATION LINKAGES

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HEATING, VENTILATION, AIR CONDITIONING, AND REFRIGERATION (HVAC/R II)

STANDARD 9.0

Students will demonstrate interpersonal and employability skills required in the heating, ventilation, air conditioning, and refrigeration industry.

LEARNING EXPECTATIONS

The student will:

9.1 Infer relationships between honesty, integrity, and organization and personal job success.
9.2 Demonstrate attitudes conducive to workplace success.
9.3 Maintain electrical and electronic equipment in a neat and orderly work area.
9.4 Assess implications of cultural and religious diversity for classroom and workplace relationships.
9.5 Develop individual and team time management and work sequencing skills to increase productivity in heating, ventilation, air conditioning, and refrigeration diagnostics and repair.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

9.1.A Illustrates the concept of integrity.
9.1.B Assesses the potential impact of an individual's work ethic on an organizational system.
9.1.C Infers the relationship between organization and personal job success.
9.2.A Modifies behavior to increase productivity in the classroom, laboratory and workplace.
9.2.B Demonstrates awareness of activities occurring concurrently in the classroom and workplace.
9.3.A Keeps electrical and electronic equipment in a clean and organized work area.
9.3.B Maintains work area according to NATEF and OSHA standards.
9.3.C Recognizes the correlation between a clean orderly work environment and successful and efficient job.
9.4.A Assesses benefits and predicts problems that may arise from diversity in work teams.
9.4.B Devises solutions to problems arising from gender, cultural, racial, and religious diversity.
9.5.A Assesses the benefits of incorporating time management principles into heating, ventilation, air conditioning, and refrigeration servicing.
9.5.B Displays time management and work sequencing skills.
9.5.C Demonstrates the ability to diagnose and repair heating, ventilation, air conditioning, and refrigeration systems within manufacturers labor operation time.

SAMPLE PERFORMANCE TASKS

- Maintain an orderly work area.
- Lead a problem-solving team.
- Consistently arrive at class on time.
- Participate in an internship in a dealership.
- Resolve an interpersonal conflict in the classroom.
- Using case scenarios follow strategy based diagnostic procedure to verify the complaint, define the problem, isolate the problem, validate the problem, make the repair, and test the repair. Complete a repair order using technical writing skills and calculate salary earnings based on the repair order description and manufacture allowances for each item on the work order. Calculate manufacturer labor operation time used in the diagnostic process.

INTEGRATION LINKAGES

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HEATING, VENTILATION, AIR CONDITIONING, AND REFRIGERATION (HVAC/R II)

STANDARD 10.0

Students will demonstrate communication skills required in the heating, ventilation, air conditioning, and refrigeration industry.

LEARNING EXPECTATIONS

The student will:

10.1 Communicate and comprehend oral and written information pertaining to heating, ventilation, air conditioning, and refrigeration.
10.2 Solve problems and make decisions using critical thinking process.
10.3 Use teamwork skills and a logical thinking process to solve problems relating to issues.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

10.1.A Interprets and uses written information in common job formats, such as tables, charts, and reference materials and manuals.
10.1.B Interprets and uses blueprints, electrical schematics, process control schematics, to solve electrical system problems.
10.1.C Uses electronic resources to obtain information.
10.1.D Analyzes information obtained from various sources to determine an electrical and electronic diagnostic solutions.
10.1.E Interprets an order for heating, ventilation, air conditioning, and refrigeration systems.
10.2.A Develops a hypothesis regarding the cause of a problem.
10.2.B Tests the hypothesis to determine the solution to the problem.
10.2.C Creates, evaluates, and revises a plan to resolve a problem.
10.2.D Implements strategy based diagnostic procedure by verifying the complaint, defining the problem, isolating the problem, validating the problem, making repairs, and testing the repairs in heating, ventilation, air conditioning, and refrigeration systems.
10.3.A Serves in each of the functional roles of a team.
10.3.B Resolves conflicts within a group.
10.3.C Demonstrates appropriate and positive examples of giving and accepting criticism.
10.3.D Modifies behavior or revises work based on appropriate criticism.
10.3.E Solves problems in cooperation with other members of a group.
10.3.F Evaluates the role of the HVAC/R technician within the organizational system of a dealership or independent shop.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Algebra, Geometry, Applied Communications, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, Plumbing, Heating, and Cooling Contractors (PHCC), Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers, ASHRAE), Air Conditioning Contractors of America (ACCA), Occupational Safety and Health Administration (OSHA), Refrigeration Service Engineers Society (RSES)

HEATING, VENTILATION, AIR CONDITIONING, AND REFRIGERATION (HVAC/R II)

STANDARDS 11.0

Students will analyze heating, ventilation, air conditioning, and refrigeration knowledge and skills and apply in a work-based or school project-based learning experience.

LEARNING EXPECTATIONS

The student will:

11.1 Apply principles of heating, ventilation, air conditioning, and refrigeration to a work-based or school project-based learning situation.

11.2 Integrate time management principles in organizing personal schedule to include school, work, social, and other activities.

11.3 Evaluate and apply principles of ethics as they relate to the work-based or school project-based learning experience.

11.4 Employ principles of safety to the work-based or school project-based learning experience.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

11.1.A Scores 80% or above on performance evaluations based on job readiness, knowledge of heating, ventilation, air conditioning, and refrigeration.

11.2 Designs a personal plan to include schedule of activities.

11.3 Records and assesses workplace events based on ethical implications.

11.4.A Scores 100% on safety performance and knowledge test covering heating, ventilation, air conditioning, and refrigeration tools and equipment and OSHA, TOSHA, and EPA rules and regulations.

11.4.B Applies safety rules and regulations to the work site.

SAMPLE PERFORMANCE TASKS

- Compose and maintain a work journal that includes general work site experiences, time management planning, and evaluation of ethical behavior.
- Create a training manual for a new employee outlining the safety considerations for the job.
- Keep a record of wages and hours-earned working on the job.
- Keep a record of personal work related expenses and budget according.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Algebra, Geometry, Applied Communications, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, Plumbing, Heating, and Cooling Contractors (PHCC), Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers, ASHRAE), Air Conditioning Contractors of America (ACCA), Occupational Safety and Health Administration (OSHA), Refrigeration Service Engineers Society (RSES)

HEATING, VENTILATION, AIR CONDITIONING, AND REFRIGERATION (HVAC/R II)

SAMPLING OF AVAILABLE RESOURCES

National Center for Construction Education and Research (NCCER), *Core Curriculum*. Prentice Hall, Upper Saddle River, NJ; ©2000. Also known as the "Wheels of Learning" materials.
National Center for Construction Education and Research (NCCER), *HVAC/R Level One*. Prentice Hall, Upper Saddle River, NJ; ©2001. Also known as the "Wheels of Learning" materials.
National Center for Construction Education and Research (NCCER), *HVAC/R Level Two*. Prentice Hall, Upper Saddle River, NJ; ©1995. Also known as the "Wheels of Learning" materials.
National Center for Construction Education and Research (NCCER), *HVAC/R Level Three*. Prentice Hall, Upper Saddle River, NJ; ©1996. Also known as the "Wheels of Learning" materials.
National Center for Construction Education and Research (NCCER), *HVAC/R Level Four*. Prentice Hall, Upper Saddle River, NJ; ©1996. Also known as the "Wheels of Learning" materials.
Refrigeration and Air Conditioning Engineers (ASHRE), www.ashrae.org
Air conditioning and Refrigeration Institute (ARI), www.are.org
Refrigeration Service Engineers Society (RSES), www.rses.org